Spray-On Bacteria Stop Potato Rot Fungus

Sometimes a little bit of antagonism can be a good thing. A recent Webster's dictionary edition defines it as "active opposition, hostility; counteraction."

At ARS' National Center for Agricultural Utilization Research (NCAUR) in Peoria, Illinois, Patricia J. Slininger, David A. Schisler, and associates are banking on a little antagonism to go a long way in protecting stored potatoes from dry rot. It's an unsightly postharvest disease that costs U.S. producers $100 million to $250 million annually in losses.

Slininger, a chemical engineer, and Schisler, a plant pathologist, are close to developing a biological approach to controlling dry rot by using bacteria that are natural antagonists of the main fungus that causes this tuber disease—*Fusarium sambucinum*. The bacteria, which are harmless to humans, colonize potato wound sites and form a kind of living bandage that keeps the fungus at bay.

Setting the Stage

"An antagonist is a microorganism that harms a plant pathogen so that its ability to infect the plant is diminished," explains Schisler, at NCAUR's Crop Bio-Protection Research Unit. "All our top bacterial strains secrete at least one antibiotic compound that inhibits the fungus's growth." One such antibiotic the researchers have identified is phenylacetic acid.

Ordinarily, the bacteria's battle for supremacy over the fungus takes place in soil or at wound sites on the potato's skin, where nutrients are precious resources to both. But the scientists' approach is to stage this fight in storage houses by spraying the bacteria directly on potatoes riding conveyor belts.

Potatoes often sustain damage during harvest or transport. So during the first 2 weeks of storage, handlers subject the new arrivals to a temperature of 59°F and 95 percent relative humidity to stimulate natural wound healing. The trick is to buy the potatoes enough time for their wounds to close up and shut out dry rot, which otherwise causes a blackish, gnarled blemish that ruins the potato's marketability.

"When we apply these bacteria, we're looking to provide a couple of weeks of protection during healing," says Schisler. "If we can do that, we've won the war in terms of controlling dry rot."

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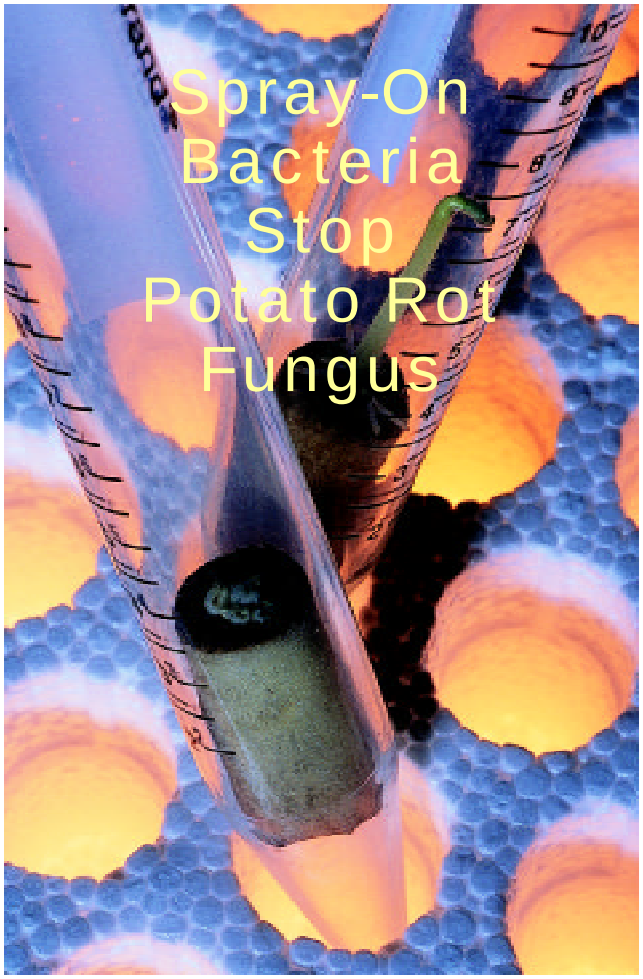

These test tubes contain potato eye cores. The one in the foreground was treated with a biocontrol agent to inhibit sprouting. The one behind it was not.

TBZ: Out of Time

ARS holds two patents on the scientists' methods to isolate and use the bacteria as dry rot biocontrol agents. A third patent covers their use to inhibit sprouting, another costly storage problem. A bacterial substance known as indoleacetic acid may play a part in sprout inhibition.

Slininger, Schisler, and NCAUR associates Karen D. Burkhead and Rodney J. Bothast began their work in 1994. That's when another NCAUR researcher, chemist Anne E. Desjardens, reported that 90 percent or more of fusarium dry rot strains she had isolated from potato fields showed resistance to thiabendazole. TBZ, as it's known, is the only chemical fungicide registered for use on potatoes stored for human consumption.

"TBZ has been in use since the 1970s, and at that time it appeared it would be an extremely effective, long-term solution," says Schisler. "Today, it's gone from being a virtual cure-all to a fungicide of much more limited use."

An uncertain future is also in store for 1-methylethyl-3-chlorophenylcarbamate (CIPC). In the United States, CIPC is the only chemical sprout control registered for use on stored, food-grade potatoes. More than half the U.S. potato crop, valued at $2.5 billion, is treated with CIPC to extend storage time and improve marketability.

Yet, despite its widespread use and importance to the potato industry, CIPC faces tighter regulation due to concerns over its persistence in both the environment and the potatoes.

A Bacterial Double Whammy

It is precisely for this reason that using antagonistic bacteria as a dual-purpose dry rot control and antisprouting agent becomes even more appealing. While CIPC affords long-term sprout control, "A biological alternative would be important where CIPC is banned, such as in organic and certain foreign potato markets," adds Slininger, who heads the research unit. "For short-term applications, such as fresh potatoes for table use, these bacterial antagonists might provide sufficient protection in place of CIPC."

Her team researched different physical and nutritional conditions for mass producing the bacteria in liquid culture fermentations. With further improvement has come a fourfold increase in bacteria, Slininger says. The microbes stay viable for at least 6 months of cold storage and can be applied with standard TBZ sprayer equipment.

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To test a new biocontrol for dry rot, plant pathologist David Schisler inoculates a wounded potato with a mixture of antagonistic bacteria and *Fusarium sambucinum* fungus.

Trial Runs

Although the scientists' research is still ongoing, their patented methods for biologically controlling dry rot and sprouting are available for licensing, says Katherine O'Hara, technology communications officer for NCAUR. Under such a license, a company could develop and market a commercial product that could benefit potato farmers and processors directly and consumers indirectly.

"Consistent effectiveness and shelf life are key factors controlling the economics and commercial viability of this biocontrol product," Slininger says. "We're making good progress on both fronts, and we hope to achieve commercial viability in the next 2 years."

Backing such optimism is several years' worth of data from both laboratory experiments and storage house studies comparing the antagonistic bacteria's performance to TBZ and CIPC.

Of six *Pseudomonas* and *Enterobacter* strains showing most promise in controlling dry rot, all curbed sprouting in stored potatoes, the scientists report. In pilot studies conducted in collaboration with United Agri-Products, Greeley, Colorado, three of these six strains controlled sprouting in stored Russet Burbank potatoes nearly as well as CIPC did over 4 months. Depending on harvest year, strain, and culture medium used, bacteria reduced sprouting by 40 to 70 percent—comparable to the 44- to 77-percent reduction observed for CIPC, says Slininger.

"But CIPC's performance was more persistent than any of the single-strain treatments, and it often continued to inhibit sprouting for more than 5 months," she adds.

In other studies the bacteria diminished dry rot by 59 percent on average, depending on cultivation medium and strains used. TBZ gave no disease protection.

Large-scale studies of bacteria strain mixtures are now being conducted with Gale Kleinkopf, a collaborating plant physiologist at the University of Idaho's Research and Extension Center in Kimberly.—By **Jan Suszkiw,** ARS.

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Chemical engineer Patricia Slininger examines a section of a potato exhibiting advanced symptoms of dry rot caused by the fungus *Fusarium sambucinum*.

This research is part of Crop Protection, Product Value, and Safety, an ARS National Program (#303) described on the World Wide Web at http://www.nps.ars.usda.gov.

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